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Since the systematic prominence observations only commenced in the year 1872, the dotted portions of the curves previous to that date are intended only to give a rough idea of the variations as based on a general repetition of the observations of 1872 to 1885.

Fortunately for the present inquiry Respighi* made some very valuable prominence observations during the years 1870, 1871, and 1872, which are sufficiently numerous to indicate the positions of the centres of prominence activity for these years. These showed that during the years 1870 and 1871 there were two well-marked prominence zones in each hemisphere, and that the latitude of one of the zones was very high. The positions of these zones are indicated in the accompanying plate by the small circles against these years, and they agree well with the dotted curves representing the probable conditions as might have been expected from subsequent observations.

The different types of corona are plotted in three different horizons in the order "polar," "intermediate," and "equatorial," and the symbols adopted for each—namely, small circles with eight rays for the first, four rays for the second, and two rays for the third—are inserted at the epochs of their occurrence, according to the general time-scale for all the curves.

The continuous and broken vertical lines denote the epochs of the Sun-spot maxima and minima, as determined from a discussion of spots recorded on both hemispheres of the Sun.

## *The Results of the Comparison.*

At the first glance it will be observed that the three types of the corona, as seen from the curve drawn through them, follow the Sun-spot curve very closely—that is, that at about the times of the maxima of Sun-spots, the "polar" type is present; at the minima, the "equatorial" type; and at the intervals between these, the "intermediate" type.

Although the Sun-spot curve thus affords a means of predicting in a general manner the epochs about which any of these types will occur, such a small restricted zone which the spots occupy excludes the idea of their presence being responsible for such widely distributed coronal phenomena.

The prominence curve, on the other hand, not only provides us with a more accurate method of forecast, but such phenomena can account for the changes of position and form of the coronal streamers.

By examining the prominence curves in relation to the three different types of coronas from the year 1869, this connection is seen to be very close. Thus, during the years 1870 and 1871, there were two centres of prominence action in each hemisphere, one of which was in high latitudes, and the coronas for that period

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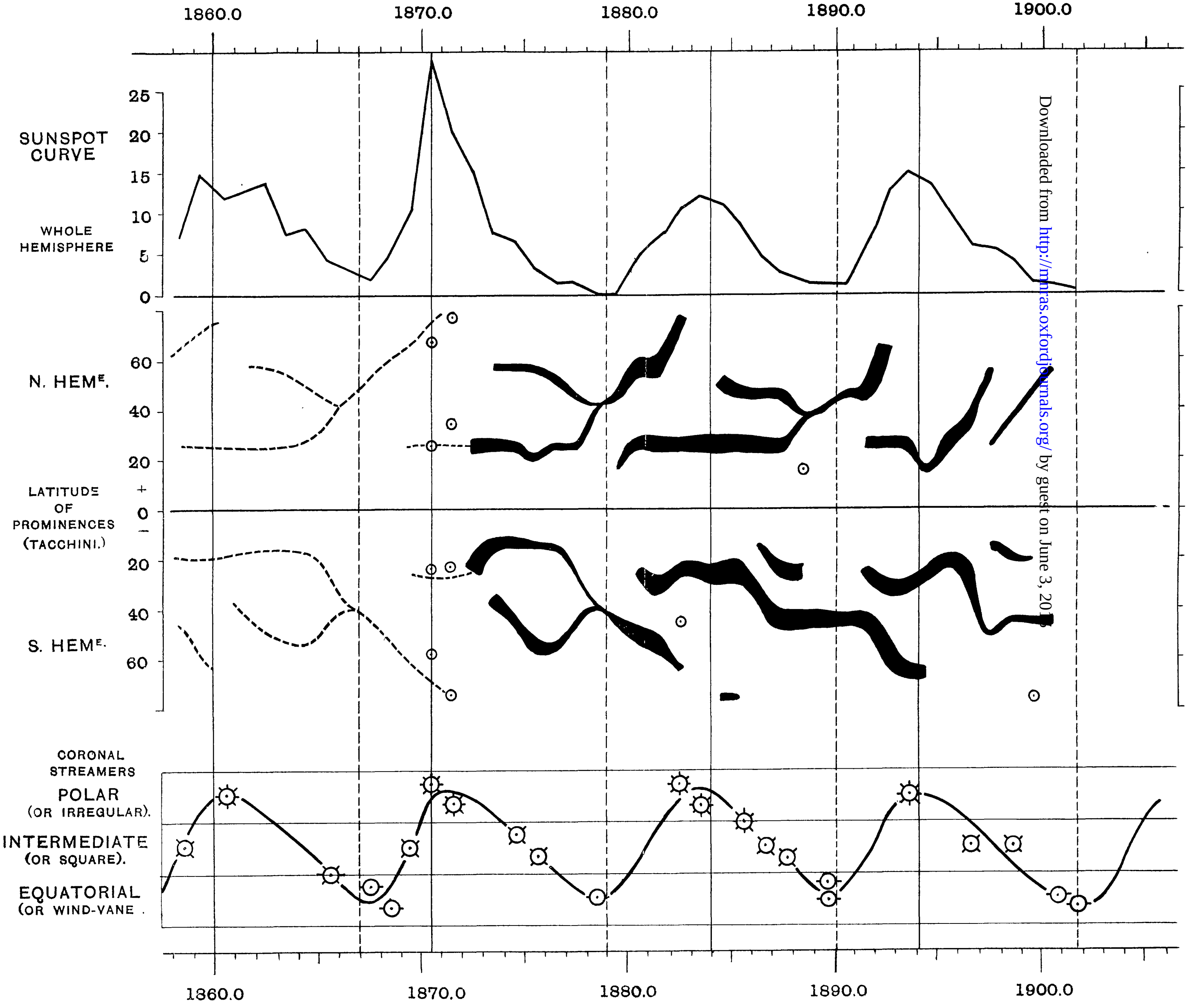
* *Solar Physics*, Appendix II. p. 654.



The vertical continuous & broken lines represent the epochs of maxima & minima of sunspot activity from a reduction of the observations of both hemispheres.

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were of the "polar" type. From the year 1872 to 1877 there were two centres of prominence activity in each hemisphere, both in comparatively low latitudes, and the two eclipses during the period, namely 1874 and 1875, were of the "intermediate" type. The next eclipse, 1878, occurred when only one centre of action was in existence, and the form of the corona was of the "equatorial" type.

As these centres of prominence action reached their extreme polar limits (about ± 80°) and a new centre had in the meanwhile commenced in lower latitudes (± 25°) the eclipses of 1882 and 1883 were of the "polar" type.

The next two eclipses, of 1886 and 1887, which were "intermediate," occurred when there were again two centres of prominence action in each hemisphere, but none near the poles. When the centres became single, as they did in the years 1889, 1890, and 1891, the two coronas observed in the year 1889 were of the "equatorial" type. With the movement of these centres to high latitudes in the years 1892, 1893, 1894, the eclipse of 1893 was of the "polar" type.

The two eclipses of 1896 and 1898, which were "intermediate" in type, occurred when there were two chief centres of prominence action, while the two most recent eclipses of 1900 and 1901 were good examples of the "equatorial" type, and were concurrent with only one centre of prominence activity in each hemisphere.

If the eclipses observed between 1856 and 1870 be compared with the dotted prominence curves for the same period, it will be seen that a similar connection seems to exist between the latitudes of the centres of action of the prominences and the three types of coronas.

### *The Duration of Prominence Action and the Resulting Coronal Streamers.*

It may here be remarked that if the prominences, which are acknowledged to be uprushes of incandescent matter into the upper regions of the solar atmosphere, are the cause of the coronal streamers (and the evidence seems to support this idea), and consequently responsible for the existence of the coronal streamers, and therefore of the shape of the corona, then the latter should alter their forms and positions not quickly but gradually, following the slow changes of the latitude and intensity of the prominence centres of action. It is the *sum total of prominence action* in the different zones which produces the large coronal streamers, and not any particular prominence at any particular moment; it is for this reason that the form of the corona is not a fleeting phenomenon changing every minute or hour, but lasting over several months, and sometimes as much as a year or more. That the general form of the corona does undergo comparatively slow changes, is borne out to a great extent by the similarity of coronas which are observed at eclipses which occur

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close together, such as those in 1900, 1901, the two eclipses in 1889, &c.

It may be suggested that the continued action of a centre of prominence disturbance in one latitude, extending over the greater part of a year or longer, would undoubtedly result in the formation of a large coronal disturbance, and form the locus of origin of a streamer situated in that region. It is also possible that this long-continued action might also disturb the solar atmosphere to such an extent that the coronal streamer might exist for a short time, even after the prominence action in this region had ceased.

The prominence curves here illustrated are determined from values which represent the mean prominence condition throughout a year. At any one moment therefore, say, during an eclipse, the prominences visible on the limb need not necessarily be situated in those particular latitudes as shown on the curves, but the probability would be that on the average they would be found near there. The non-coincidence of the position angle of a long coronal streamer with that of a large prominence is not necessarily a criterion that prominences as a whole do not cause the former.

## *The Structure and Formation of Streamers.*

It is of great interest to briefly note the connection between the centres of prominence action when either two or one of them exist in each hemisphere. In the first place, a well-defined large coronal streamer apparently originates, as many photographs indicate, not from disturbances at the *centre* of its base, but at the two ends. Such a streamer is generally made up of groups of incurving structure, termed by Ranyard[*] "synclinal" groups, and this structure is in many cases very distinct. When there are *two* centres of prominence action in one hemisphere, the coronal disturbances resulting from each trend towards each other and constitute a large streamer with an apparent "arch" formation. If the two centres of prominence action exist in comparatively mid-latitudes, one large streamer is formed in each quadrant, and the form of the corona is of the "intermediate" or "square" type.

When one of the centres is near the region of the poles, and the other in comparatively low latitudes, the tendency is still for the two disturbed coronal regions to trend towards each other, but they constitute either a large streamer of an "arch" formation nearer the solar poles with a very extended base, or two separate streamers.

With *one* centre of action of prominences in each hemisphere, the resulting coronal disturbances in both hemispheres curve towards the solar equator and form apparently a large equatorial streamer: the "equatorial" type of corona is here formed.

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[*] *Mem. R.A. Soc.*, vol. xli. p. 486.

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The accompanying sketches illustrate in diagrammatic form the general relationships between the latitudes of the spot zones, the latitudes of the centres of action of the prominences, and the suggested resulting positions and origin of structure of the coronal streamers for each of the three types of coronas here discussed. It will be noticed that in the case of the "polar" and "intermediate" types, when the Sun-spots are numerous, the zones in which they occur have apparently little connection with the coronal streamers. When the latitudes of the spot zones do approximate more nearly to the bases of the coronal streamers, as in the "equatorial" type, and might be considered as being the origin of their existence, the spots at these epochs are near a minimum—that is, are very few and small in size and have the least power of action.

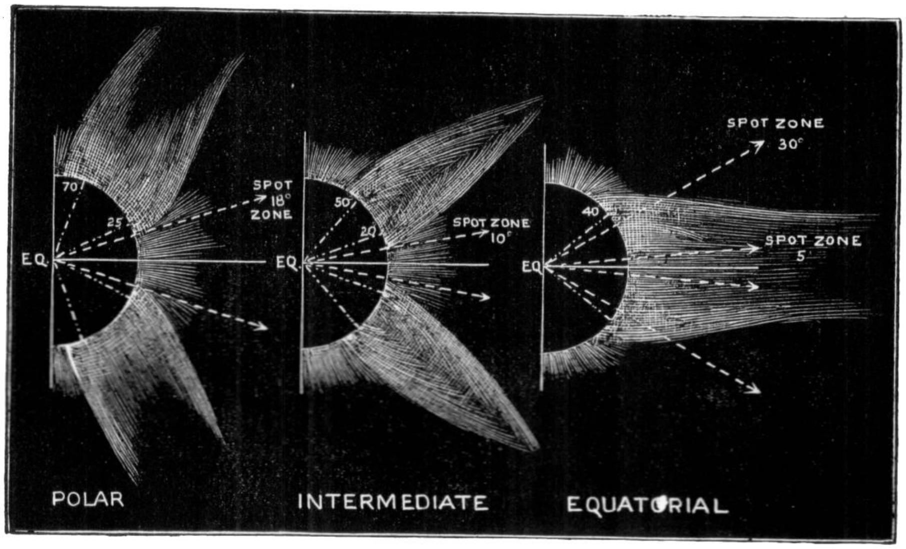

Diagram showing by short radial lines the positions of the centres of prominence action in relation to the chief features of individual coronal streamers and the general forms of the corona. The positions of the Sun-spot zones are indicated by the longer radial lines. The three types of coronas are here illustrated.

In conclusion, I wish to express my thanks to Mr. W. H. Wesley, of the Royal Astronomical Society, for his kindness in answering numerous questions relating to different coronas with which he was familiar.

## *Conclusion.*

The following is a summary of the conclusions arrived at in the preceding paper :—

1. The "forms" of coronas may be grouped generally into three classes, here named "polar," "intermediate," and "equatorial," according as the streamers appear near the solar poles, in mid-latitudes, or about each side of the equator.

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2. The sequence of these forms, if sufficient numbers of eclipses occurred, should be equatorial, intermediate, polar, intermediate, equatorial, &c.

3. The various forms of the corona are closely connected with the positions (as regards latitude) of the centres of action of the solar prominences.

4. The coronas of the "polar" or irregular type occur about the times when the prominences are most abundant near the solar poles.

5. The "equatorial" coronas occur when there is *one* centre of prominence action (about latitude ± 45) in each hemisphere.

6. The "intermediate" type is produced by two centres of prominence action in each hemisphere, but neither centres near the poles.

7. The peculiar "arched" form of some streamers is produced by the action of two zones of prominences situated near the extremities of their base.

8. Sun-spot activity has apparently no *direct* connection with the production of the coronal streamers.

## *Experiments as to the Actuality of the "Canals" observed on Mars.*

By J. E. Evans and E. Walter Maunder.

The experiments described in the following paper were undertaken in order to ascertain whether the impression of a network of fine lines, such as forms what is now known as the "canal system" of *Mars*, could be produced upon entirely unbiassed observers without those lines having a real objective existence; and, should this prove to be the case, to find out the conditions most favourable for the creation of such an impression.

The experiments were made in the following manner. A circular disc, varying according to circumstances from 3·1 to 6·3 inches in diameter, was given to a class of boys to sketch. The boys in the class were usually twenty in number, and were seated at various measured distances from the disc. These distances varied in the extreme from 15 feet up to 62 feet, but more generally from about 17 feet to 38 feet. The boys were all supplied with a piece of drawing-paper upon which a circle 3 inches in diameter had been described, and were instructed to fill in that circle with all the details which they could perceive upon the disc. No hint was given them that they ought to see lines or dots or any other form of marking; they were simply urged to draw all that they could see and be sure of, each for himself, without noting what his neighbours were drawing. They were carefully watched during the experiment, and there can be no doubt at all that the drawings were independent; indeed, the internal evidence of the drawings themselves is sufficient to prove